

Indicator: Fish Faunal Intactness (128)

Intactness, the extent to which ecological communities have retained their historical composition, is a critical aspect of the biological balance of the Nation's ecological systems (NRC 2000). It is of particular importance in freshwater systems that are impacted by pollution, habitat alteration, fisheries management, and invasive species.

This indicator tracks the intactness of the native freshwater fish fauna in each of the nation's major watersheds by comparing the current faunal composition of those watersheds with their historical composition. Specifically, the indicator measures the reduction in native species diversity in each 6-digit USGS hydrologic cataloging unit (HUC) in the 48 conterminous states. Intactness is expressed as a percent based on the formula:

$$\text{reduction in diversity} = 1 - (\# \text{ of current native species} / \# \text{ of historic native species}).$$

The native species diversity indicator proposed by the NRC (NRC 2000) compared expected native species diversity with observed diversity, with the "expected" value projected from species-area-curve models. This "Fish Faunal Intactness" indicator makes use of empirical, rather than modeled data sets, and focuses on a well-known group of organisms with a fairly strong historical record.

The fish distributional data underlying this indicator were gathered by NatureServe, a non-profit research organization, and are derived from a number of sources, including species occurrence data from state natural heritage programs, a broad array of relevant scientific literature (e.g., fish faunas), and expert review in nearly every state. These data were assembled during the period 1997-2003. The underlying data include distributions for 782 native freshwater fish species across small watersheds (8-digit HUC). For this indicator, data were pooled and reported by larger 6-digit HUCs to reduce potential errors of omission in the smaller watersheds.

What the Data Show

Watersheds covering about one-fifth (21%) of land area in the conterminous United States are fully intact, retaining their entire complement of fish species (Figure 128-1). Watersheds covering nearly a quarter (24%) of land area, however, have lost 10% or more of their native fish fauna. Reductions in diversity are especially severe in the Southwest (e.g., the lower Colorado River watershed) and the Great Lakes, with eight major watersheds (representing 2% of total land area) having lost more than half of their native fish fauna.

Indicator Limitations

- The incomplete historical record for freshwater fish distributions and inconsistent inventory records for contemporary fish distributions are sources of uncertainty.
- Because the indicator is expressed as a ratio, it does not reflect the magnitude of species losses in a given watershed. The southeastern United States, for instance, is far richer in numbers of freshwater fish species by HUC than the southwestern United States. Although some southeastern HUCs have experienced significant losses in the absolute number of species (e.g., in the state of Mississippi), due to the large number of species overall, the fish fauna can still appear relatively intact when viewed on a percentage rather than numeric basis.
- Although NatureServe has attempted to compile the most complete distributional information possible for these species at the 8-digit HUC level, these data are dynamic: new records frequently are added and existing records are revised as new information is received and as

taxonomic changes occur. Consequently, these distributional data could benefit from additional quality control, updating, and expert review.

- The period of record currently is too short to track trends in fish faunal intactness, but this indicator provides a sound baseline for the period 1997-2003.

Data Sources

The identity and status (current vs. historical) of all native fish species recorded in each 8-digit HUC are available at: <http://www.natureserve.org/getData/dataSets/watershedHucs/index.jsp>. Species-by-species distribution maps at the 8-digit HUC level are available on the NatureServe Explorer website (www.natureserve.org/explorer). Analyses based on these data have previously been reported in Master et al. (1998), Master et al. (2003), and Stein et al. (2000).

References

Master, L.L., S.R. Flack, and B.A. Stein. 1998. "Rivers of Life: Critical Watershed for Protecting Freshwater Biodiversity." The Nature Conservancy, Arlington, VA. Summary available at <http://www.natureserve.org/publications/riversOfLife.jsp>.

Master, L., A. Olivero, P. Hernandez, and M. Anderson. 2003. Using small watershed fish, mussel, and crayfish historical and current presence data to describe aquatic biogeography and inform its conservation. Abstract # PO67. Society for Conservation Biology Annual Meeting, Duluth, Minnesota. Abstract available at <http://www.d.umn.edu/ce/conferences/scb2003/poster.htm>.

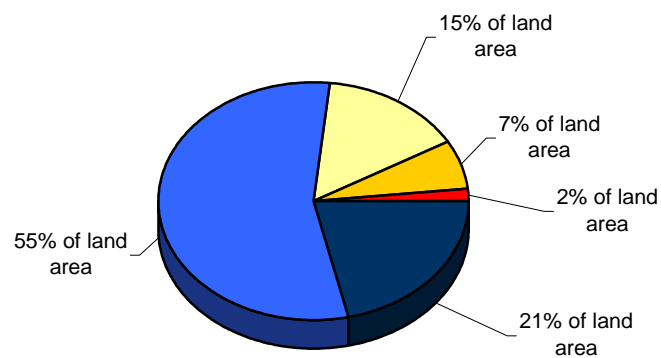
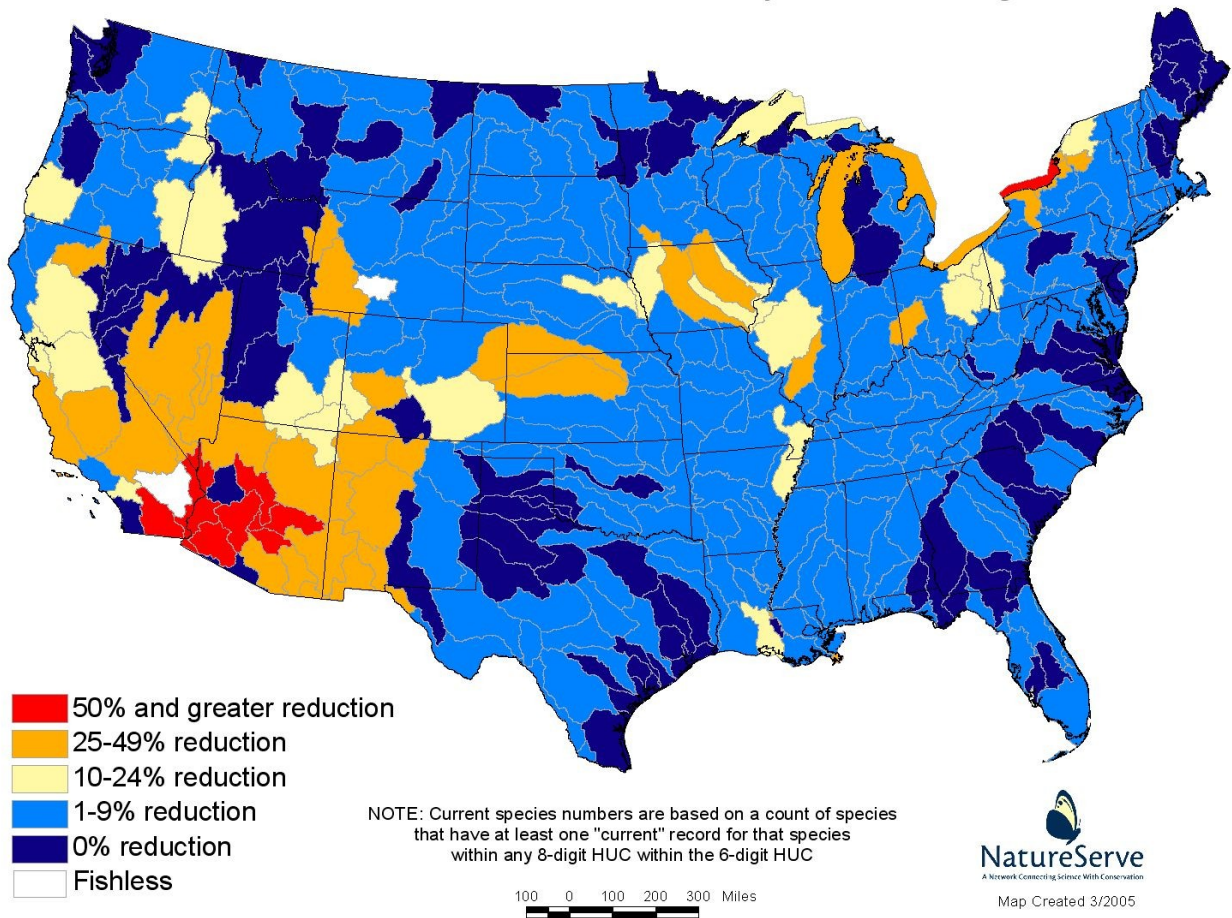
National Research Council (2000). "Ecological Indicators for the Nation". National Academy Press, Washington, DC. Full text available at <http://www.nap.edu/openbook/0309068452/html/>.

Stein, B.A., L.S. Kutner, and J.S. Adams. 2000. "Precious Heritage: The Status of Biodiversity in the United States". Oxford University Press, New York. Summary available at <http://www.natureserve.org/publications/preciousHeritage.jsp>.

Graphics

Figure 128-1.

% Reduction in Native Fish Fauna Diversity Within a 6-digit HUC



R.O.E. Indicator QA/QC

Data Set Name: FISH FAUNAL INTACTNESS

Indicator Number: 128 (116468)

Data Set Source:

Data Collection Date:

Data Collection Frequency:

Data Set Description: Fish Faunal Intactness (NatureServe)

Primary ROE Question: What are the trends in the diversity and biological balance of the Nation's ecological systems?

Question/Response

T1Q1 Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

Yes. The methods make use of well-established techniques for documenting species distributions. These distribution data focus on the current and historic distributions by small watershed (USGS 8-digit hydrologic cataloging unit) of all native freshwater fishes of the United States, exclusive of Alaska and Hawaii. These data derive in part from precise locational data (element occurrences) compiled by state natural heritage programs for vulnerable or imperiled fish species. Standards and protocols for documenting and mapping element occurrences are described in Stein et al. (2000) and available at: <http://www.natureserve.org/prodServices/eodata.jsp>. These natural heritage locational data were supplemented with information from the scientific literature and from individual species experts. State and regional experts then reviewed the data to refine the small-watershed distribution for these species. Current and historical species distributions were mapped using a geographic information system, and resulting 8-digit HUC range maps for each of the 782 native freshwater fish species are available at <http://www.natureserve.org/explorer>. These data are also summarized for each of the 2,064 8-digit HUCs in the conterminous US at: <http://www.natureserve.org/getData/dataSets/watershedHucs/index.jsp>. Distributional data at the 8-digit HUC level were then pooled by 6-digit HUC and the number of native species calculated. These data were compiled over a six year period, from 1997 to 2003. Results based on these data have been presented in Master et al. 1998. "Rivers of Life: Critical Watershed for Protecting Freshwater Biodiversity" (<http://www.natureserve.org/publications/riversOfLife.jsp>). The Nature Conservancy, Arlington, VA., Master et al. 2003, . Using small watershed fish, mussel, and crayfish historical and current presence data to describe aquatic biogeography and inform its conservation (<http://www.d.umn.edu/ce/conferences/scb2003/poster.htm>). Abstract No. PO67, Society for Conservation Biology Annual Meeting, Duluth Minnesota, and Stein et al. 2000. Stein, B.A., L.S. Kutner, and J.S. Adams. 2000. "Precious Heritage: The Status of Biodiversity in the United States" (<http://www.natureserve.org/publications/preciousHeritage.jsp>). Oxford University Press, New York.

T1Q2 Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

Yes. These data are derived from the existing scientific record of collections and observations, rather than through a de novo sampling and inventory program. The distributions of freshwater fishes are relatively well known, due to a combination of 1) extensive scientific inventory and collection efforts directed towards this faunal group, 2) widespread use of fishes in water quality sampling programs, and 3) the activities of both recreational and commercial fisheries. The indicator is designed to rely on presence data alone, and as such can accept validated data from any of these sources.

T1Q3 Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

Yes. The conceptual model used for this indicator is based on a recommended indicator—Native Species Diversity—in the National Research Council (2000) report “Ecological Indicators for the Nation.” It differs from that approach, however, in using empirical data (historical composition) rather than modeled data as a baseline for comparison. The indicator is also conceptually similar to an Index of Biotic Integrity, in which a known sample is compared with a reference condition (e.g., Karr et al. 1986. Karr, R. J., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessment of biological integrity in running waters: A method and its rational. Illinois Natural History Survey special Publication No. 5. Illinois Natural History Survey, Champaign, IL). In this instance, the reference condition is the documented historic composition of the fish fauna, with the “sample” the current native species composition.

T2Q1 To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

The indicator speaks directly to a central issue of relevance to the ROE, that is, what is the biological condition of the nation’s ecosystems, and how are they changing? In this instance, the key change being measured is the degradation of faunal communities at a regional scale, as measured by reduction in native species diversity. Indeed, this is one of the few groups for which data is sufficiently robust to provide such a measure of faunal intactness.

T2Q2 To what extent does the sampling design represent sensitive populations or ecosystems?

Although this indicator tracks overall loss of diversity in major watersheds, many of the watershed-level species losses involve rare or endangered species. The indicator is particularly robust in its representation of sensitive populations because the underlying data draw from the most comprehensive database available on the known localities for rare and endangered species in the United States. Furthermore, the distributions of these species have been reviewed by state and regional experts, including natural heritage biologists, who represent some of the foremost authorities on the distribution of rare sensitive species and populations in their states.

T2Q3 Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

There are no established thresholds for what constitutes the desirable state of intactness for a major watershed. We use 10%, 25%, and 50% reductions as thresholds. The threshold for what constitutes “historical” occurrence was set at 1970 (i.e., 25 years), consistent with established NatureServe guidelines for assigning population viability assessment ranks (“EO Rank Specifications”).

T3Q1 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

Documentation for the underlying data set used in the calculation of this indicator is available at: <http://www.natureserve.org/getData/dataSets/watershedHucs/index.jsp>.

T3Q2 Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

Data on the identity and status (current vs. historic) of fish species recorded for each of the 2,064 8-digit HUCs in the conterminous United States are available at: <http://www.natureserve.org/getData/dataSets/watershedHucs/index.jsp>. Distribution data for each of the 782 native US freshwater fish species included in the study is available on the NatureServe Explorer web site (www.natureserve.org/explorer).

T3Q3 Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Yes.

T3Q4 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

The description of the approach followed, which involved quality control by state and regional experts for state and regional subsets of the data, is described in Master et al. (1998). Each record for a fish species in an 8-digit HUC was documented in a database with the source of that record, permitting users of the data to check the sources of the information recorded. The development of this distributional database represents a best effort given the available resources and data at the time. Additional resources and research would undoubtedly uncover more data sources, which would likely yield additional database records.

T4Q1 Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

This indicator is based on direct calculation, and does not make use of statistical inference.

T4Q2 Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Incompleteness in the historical record for freshwater fish distributions and inconsistent inventory records for contemporary fish distributions are sources of uncertainty. There is no current means for measuring the level of such underlying uncertainties.

T4Q3 Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

Uncertainties in the indicator relate to gaps in either inventory coverage or in database capture of available distributional records. Historical data are most likely to be subject to gaps in coverage, although the mechanism by which the indicator is calculated ameliorates this by including all contemporary and historical species in the denominator of the indicator formula. In other words, for this purpose, all contemporary species are also assumed to have been present historically. In certain circumstances (e.g., where an undocumented historical species has disappeared from a watershed) the resulting underestimate of historical distributions would have the effect of decreasing the baseline (denominator), and increasing the apparent intactness of the watershed. Conversely, there are undoubtedly instances in which a species continues to exist in a watershed, but has not been documented since 1970, or those reports were not captured in the creation of this dataset. This would have the effect of overstating apparent reductions in diversity. These potential errors, and their associated uncertainties, will be most significant at the 8-digit HUC level, which represents the geographic scale at which these distributional data were gathered. Pooling these distribution data by the 334 6-digit HUCs (vs. > 2,100 8-digit HUCs) and reporting out the indicator at that geographic level, has the effect of decreasing the potential impact of these uncertainties.

T4Q4 Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

This indicator provides information about the degree to which current fish faunas have changed relative to historical conditions, based on the analyzed data sources. As such, the indicator currently represents a baseline, which could be improved with analysis of additional data sources. Future updates of the underlying data would be required to document a continuation of the trends displayed.